The Four-Direction Orbit: Width, Tilt, Molecules and the Hidden Rotation

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Abstract

The electron orbits the nucleus in four spatial directions, and the light of a line has the frequency of the orbit's motion in the fourth direction. This paper reports what that orbit does when its conditions change. A nucleus of finite width gives the hydrogen line Lyman-γ at one Bohr radius to 0.13%. The tilt of the orbit into the fourth direction moves the line by only 1.4% between 5° and 85°. The uniform background couples to the electron's orientation through a plane inside our own directions. Around two nuclei the same orbit gives the colours of the four diatomic halogens with one constant, and around a chain of nuclei it moves the line from the ultraviolet toward the visible as the chain grows. A second electron rotating in a hidden plane exchanges energy with the orbit at two sharp resonances and does not lock to it. The paper also records where the orbit does not yet match: the circular orbit with Lyman-γ at one Bohr radius is not the one with hydrogen's binding energy, and the long polyene chains come out too red.

1. The orbit

The nucleus is the proton pattern of finite width. Its two up quarks pull on the electron through the four-direction distance and its down quark pushes through the three-direction distance, each softened over its own width:

$$V = -(4/3)/\sqrt{(\rho^2 + R_u^2)} + (1/3)/\sqrt{(r_3^2 + R_d^2)}, \quad R_u = 0.01524 \text{ s}, \quad R_d = 0.00653 \text{ s}$$

in Bohr radii, with one width parameter s. The electron is launched on a circular orbit of radius r at the circular speed, tilted into the fourth direction. The line is the frequency of the fourth-direction motion.

At s = 100, r = 1 and a 10° tilt the line is 0.4693522 hartree, 97.08 nm. Lyman-γ is 97.20 nm for an infinitely heavy nucleus (0.13%) and 97.25 nm as measured (0.18%).

2. Width and binding energy

The circular orbit's energy at radius r is half its speed squared plus the potential. As the orbit moves inward the net pull weakens, because the up-quark pull softens over a wider region than the down-quark push, and at an inner edge the net pull vanishes and the circular speed falls to zero.

Width s	Hydrogen's −0.4997 reached?	Lowest circular-orbit energy (Ha)	At radius (a_0)
90	yes, at r = 0.841	below −0.4997	inside 0.841
92	no	−0.4930	0.834
95	no	−0.4774	0.861
100	no	−0.4536	0.906

At s = 92, 95 and 100 the lowest energy sits at the inner edge, where the circular speed is zero.

Hydrogen's binding energy is reachable for widths up to s ≈ 90.5. At s = 90 the orbit with that energy has radius 0.841 and line 0.566 hartree, not Lyman-γ. The line at r = 1 falls with the width:

Width s	90	92	95	100
Line at r = 1 (Ha)	0.522	0.511	0.495	0.469
Orbit energy at r = 1 (Ha)	−0.469	−0.463	−0.454	−0.440

So among circular orbits, the one with Lyman-γ at one Bohr radius (s = 100) and the one with hydrogen's binding energy are different orbits.

3. Tilt

The tilt sets how far the orbit leans into the fourth direction. At s = 100, r = 1:

Tilt	5°	10°	20°	30°	45°	60°	75°	85°
Line (Ha)	0.46923	0.46935	0.46984	0.47054	0.47212	0.47389	0.47537	0.47594
Line (nm)	97.10	97.08	96.98	96.83	96.51	96.15	95.85	95.73

The line moves 1.4% across the whole range. The tilt is not what fixes the line; the force law is.

Thickness in the fourth direction. The zero-point energy of the fourth-direction motion, half its frequency, is 0.235 hartree, about twenty times the orbit's kinetic energy of 0.012. The electron's spread along the fourth direction at that frequency is 0.73 Bohr radii. The nucleus, 1,836 times heavier and held by the electron's pull, spreads 0.10 Bohr radii. Atoms are thin slabs in the fourth direction, and the heavy nuclei are the thinnest part.

4. What holds the orbit's plane in our directions

The uniform background field couples to an electron-type pattern through a cross term. For the background state and each electron-type seed, the coupling vector is exact and lies on exactly one pair of directions, the pair whose occupation differs from the background's, with the circular combination (1, ±i). For the two electron-type seeds the pair is directions 3 and 4, or directions 1 and 2. Both pairs lie in the base four: the three observed directions and the fourth.

The term acts through the projection of this vector onto the electron's bound directions. A bound set that contains the base four holds it in full; a bound set tilted out of it holds less. So the uniform background couples to the electron's orientation, and it does so through a plane of our own directions. This is the first link found between the electron's bound set and the observed directions. The energy's sign, the restoring force and the rate need the second-order energy.

5. Molecular colour

Diatomic halogens. Two nuclei sit at the measured bond length R, and the electron orbits around both at radius r = 1 + R/2 Bohr radii, the hydrogen radius measured from the bond's midpoint plus half the bond:

Molecule	Bond (Å)	Orbit line (nm)	Measured absorption maximum (nm)	Ratio
F_2	1.412	151	285	0.53
Cl_2	1.988	203	330	0.62
Br_2	2.281	233	415	0.56
I_2	2.666	274	520	0.53

The line moves into the visible with the bond length in the same order as the measured colours, and one constant, about 1.75 in energy, carries the orbit line to all four maxima within 9%. From F_2 to I_2 the orbit line grows by 98 nm per ångström of bond and the measured maxima by 187 nm per ångström. The factor of 1.75 is open. With the electron pair in place of one electron the orbit lines are 171, 229, 255 and 287 nm.

Polyene chains. For a chain of N carbon nuclei spaced 1.40 Å apart, with the electron orbiting the whole chain:

Carbons	2	4	6	8	10	12	22
Measured maximum (nm)	165	217	253	304	334	364	452
Orbit line, one electron (nm)	151	278	416	557	698	840	1,552
Orbit line, electron pair (nm)	170	290	426	567	708	850	1,562

Ethylene, the two-carbon chain, comes out at 170 nm with the electron pair, against 165 nm measured. The line moves to longer wavelengths as the chain grows, as the measured colours do, but the orbit around the whole chain is a far-field orbit whose line falls as r^(−1.5), and from four carbons on it is too red: 3.4 times the measured wavelength at 22 carbons. Raising the tilt from 5° to 80° shifts these lines toward the blue by at most 11% (1,554 to 1,380 nm at 22 carbons), and no tilt reaches a measured value. A racetrack path along the chain keeps the electron near each nucleus and holds the line at 80 to 100 nm for every length, too blue. The measured series lies between the two paths.

6. A second electron in a hidden plane

Two electrons orbit as a mirror pair in the four directions, and each also sits on a ring in a hidden plane (directions 5 and 6), at hidden angles whose difference ψ rotates at the rate ψ̇. The pair repels through the full distance, the four-direction separation plus the hidden chord, at a weak coupling (0.02 of the full strength) so that the orbit stays near the reference orbit. The scan runs ψ̇ from 0.1 to 12 times the orbital rate, each for 300 orbits, and records the largest change of the orbit's energy and the largest fourth-direction amplitude.

ψ̇ / orbital rate	Largest energy change	Largest fourth-direction amplitude
0.1 to 3.0	3 to 8 × 10^{-4}	0.059
3.2	2.1 × 10^{-3}	0.060
3.6	2.4 × 10^{-2}	0.064
4.1 to 5.2	1.4 to 3.4 × 10^{-4}	0.059
5.85	3.3 × 10^{-4}	0.066
6.6 to 12	1.2 to 1.9 × 10^{-4}	0.059 to 0.060

There is no lock at 1:1: at equal rates the orbit is undisturbed. The hidden rotation acts on the orbit at two sharp resonances. Near 3.6 times the orbital rate energy passes between them and the orbit's energy changes by up to 2.4%, about eighty times the background. Near 5.9 times the orbital rate the energy is undisturbed but the fourth-direction amplitude rises from 0.059 to 0.066 on the scan grid, and to 0.096 at the peak on a finer scan. The fourth-direction line sits at 3.0 times the orbital rate, and the first resonance lies just above it.

7. Summary

The four-direction orbit around a nucleus of finite width gives Lyman-γ at one Bohr radius to 0.13%, and the line hardly depends on the tilt. The atom is a thin slab in the fourth direction, thinnest at the nucleus. The uniform background couples to the electron through a plane of our own directions. Around two nuclei the orbit gives the order of the halogen colours, with one constant to the measured maxima, and around a chain it moves the line toward the visible as the chain grows. A second electron

rotating in a hidden plane resonates with the orbit at two sharp ratios and does not lock to it.

8. Open items

- The orbit with hydrogen’s binding energy and the orbit with Lyman-γ at one Bohr radius are different circular orbits. Eccentric orbits with hydrogen’s energy have not been examined.
- The angular momentum of the circular orbit at s = 100, r = 1 is 0.156, below ħ/2.
- The factor of about 1.75 between the halogen orbit lines and the measured maxima.
- The path that gives the long polyene chains, between the orbit around the whole chain and the racetrack along it.
- The sign and size of the background’s coupling to the electron’s orientation.